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My interpretations were influenced by what seemed to me negative evidence both in topographic forms and in surficial materials throughout the lower ranges and intervening plains of western Sonora and southern Arizona. I have ridden over and camped on the country between Arivaca and Sopori (mentioned by Dr. Merrill), where the erosion forms assumed by the widespread tuff beds often simulate morainal deposits in general landscape effects, without finding indications of glacial agency either in deposits or in minute topography; while over the more elevated remnants of eroded ranges and among the lower slopes of the more rugged sierras most of the topographic forms impressed me as not merely water-cut but carved in that peculiarly acute fashion characteristic of the margins of sheetflood plains. Some of these plains are indeed diversified, especially toward the mountain margins, with both basin-shape depressions and debris-heaps, the latter frequently near the valleyward extremities of the former—the basins having been originally places of concentrated flow of the (generally dwindling) sheetfloods, and the debris-heaps the delta-like accumulations by which the localized corrosion was originally checked; though the heaps usually outlast the basins, especially when composed largely of obdurate rock-fragments, and form a type or genetic class of those natural mounds which are of late attracting much attention. The region is one of distinctively significant geomorphy; for it is not only the type district of sheetflood erosion, but comprises an extensive area of retrogressive carving due to a southwestward tilting—an area in which the general divides seldom coincide with the axes of the sierras but run far out on the low-lying plains between, circumscribing the head slopes of waterways (of which Rio Seco and Rio Bacuache are types) that have retrogressed northeastward entirely through the ranges in which they originally headed. Several examples of this remarkable retrogression were surveyed and mapped in detail by Willard D. Johnson in connection with that expedition which yielded his notable map of Seriland published in the *National Geographic Magazine* and also

in the Seventeenth Annual Report of the Bureau of American Ethnology; unfortunately, these surveys have not yet been published. During this same expedition Mr. Johnson worked over most of the surface and ascended most of the crests along the valleys lying next west of that of the Imuris; but neither he nor I noted ice-shaped topography anywhere in the region. Of course, any negative inference is worth far less than the positive inductions of a geologist familiar, like Doctor Merrill, with such glacial topography and deposits as those of northeastern United States; yet it is worthy of consideration pending more extended surveys than have thus far been found practicable in the Sonoran province.

W. J. MCGEE.

SAINT LOUIS PUBLIC MUSEUM.

THE EARTHQUAKE AND PROFESSOR LARKIN.

In the *Open Court* for July, 1906, is a remarkable account of 'The Great San Francisco Earthquake,' from the pen of Edgar L. Larkin, of the 'Lowe Observatory on Echo Mountain,' otherwise professor of astronomy and geology in the University of the Sunday Supplement.

Professor Larkin came to San Francisco immediately after the earthquake of April 18. In a day or two he was able to discover a number of things which had escaped the notice of the local geologists, Lawson, Branner, Gilbert, Campbell, Davidson and others, constituting the official State Earthquake Commission.

Professor Larkin says: "One of my objects in leaving the peace and quiet in the observatory on the mountain, to make a five-hundred-mile journey to the stricken city, was to study the action of the earthquake in the great cemeteries. The fallen columns write the history of the convulsion in stone." To his surprise he found that "the half dead made their homes with the dead. Weak and wan girls played with the marble angels. * * * One desolate family found shelter in a beautiful sepulchre while the sufferers rested their heads on lowly graves." This was the more remarkable, for, as Jerome Hart suggests in the same connection, there is in California a

deep-rooted superstition that it is unlucky to be killed by a falling tomb during an earthquake. Yet in this stress, superstitions fell away like dead leaves and the people slept through the long night with fallen angels among beds of violets.

And this stress was, indeed, terrible. "The Pacific," observes Professor Larkin, "was startled with the onrush of the terror-stricken. * * * The glorious poppies of California vied with each other in striving to attract attention away from the appalling scene * * * but in vain."

"One of the most vivid, awe-inspiring and impressive facts * * * is this: the people in the city did not hear subterranean sounds! But the awful reason why was because of the terrible roar roundabout, from seething flames, tumbling walls, the crashing of glass and the hissing of sliding, rasping miles of wire. The literature of earthquakes does not present a more striking and startling fact, for the roaring of the city all aflame was louder than the thundering in caves of gloom below." Other observers failed to note that the city was already roaring with 'seething flames' in the forty-seven seconds through which the shock lasted.

It is interesting to see how accurately the lower animals predicted the earthquake. In San José, eighteen minutes before the shock, "two mares with young colts were running and whinnying * * * in alarm as though dogs were after them. Dogs were there, but they, too, gave unusual warning of danger. * * * I have," observes Professor Larkin, "a mass of facts that can not be mentioned in less space than a good-sized book." It was in San José, also, three days before the earthquake, so I am informed, that a cat was heard to utter three sounds sharp and high, these followed by a hiss as of escaping steam. A dog was present and appeared also agitated. It was noticed that the dog's nose was cold, while the tail of the cat was rigidly erected. At Petaluma, it is said, a cock (white Leghorn) crowed three times, on the morning before the shock.

"Many fish," continues Professor Larkin, "were killed along the coast and as far south

as Los Angeles. And fish taken from the sea opposite Los Angeles had such a strong odor of sulphur that they could not be eaten." This is the more remarkable as Los Angeles is five hundred miles from the point where the earthquake rift leaves the sea. But it may be noted also that the shock went twice around the world, and that there were fishes in the market of Tokyo on April 18 that had also such a strong odor that they could not be eaten. It is not stated whether the odor was that of sulphur, a matter to be investigated. In or near London, two months later, an odor of sulphur, or sulphuretted hydrogen, was detected in certain suddenly opened eggs which had been laid on or near the eighteenth of April. This is given on the authority of a distinguished actor lately returned from a tour in the provinces.

Another 'remarkable' fact is this: "The immense bay of San Francisco is filled and emptied by tides. The volume of water is enormous, and if forced through the Golden Gate, the current would be rapid, indeed. No such velocity exists, hence there may be an underground connection with the ocean." It is a singular fact that none of the local geologists have ever seen San Francisco Bay emptied. Still it might happen under cover of dense fog. In any case no great stress should be laid on this failure to observe, which has at most merely negative value.

Professor Larkin notices that although no sun spots greater than twice the size of the earth were visible at that time, yet on April 18 the sun, moon, Mercury, Venus, Mars, Jupiter and Saturn were massed within five hours twenty-eight minutes of right ascension. But, again, as the earthquake occurred at five o'clock thirteen minutes, this can not be held to prove anything; the seventeen minutes of discrepancy can not be overlooked. Moreover, Professor Larkin tells us the earth was at the time only 618,000 miles out of her usual orbit. This is not much for a globe which travels three hundred millions of miles a year and so is accustomed to deal with large figures.

The display of blue flames before the onslaught of the red ones, and their final yellow sequences was very remarkable. "The appear-

ance of blue lights," says Professor Larkin, "was over a wider area than at first thought. At Petaluma * * * blue flames eighteen inches in height played over a wide expanse of marsh land." Before the earthquake only "a flickering ominous haze was seen playing above the ground." "A dark funnel-shaped mass was seen in Fourth Street, San Francisco, suspended in the air, and it was illuminated by scintillating lights, like fire-flies." "Blue flames were seen hovering over the bases of foothills in western San Francisco." In San José, on the street called the Alameda, looking eastward, at the time of the shock the whole street was seen "ablaze with fire, it being of a beautiful rainbow color but faint. This, no doubt," observes Professor Larkin, "was an electrical display, for had gas been on fire all along the street the houses would have been ignited. And letters from a point north of San Francisco describe blue lights as flickering like an aurora over a wide area of marsh land with a troubled surface of adjoining water. And can it be that the giant Electricity took part in the vast seismic turbulence? * * * The writer scarcely knows which one of the multitude of theories regarding the cause of earthquakes to adopt."

Later Professor Larkin grows more confident and asserts that "the San Francisco earthquake was due to a readjustment of the edge of the layers once torn apart when the earth was young. * * * It appears that two faults were involved. * * * I do not wish to assert that the earth's charge of electricity helped in the havoc, but believe that it did. That giant is able to do any vast work."

No wonder that in Professor Larkin's mind 'great questions arise.' "Did man appear on earth before his dwelling was ready? Does nature care whether man exists? It is asserted that she has slain thirteen million human beings by convulsive force alone within the historic period."

'Swing low, Sweet Chariot,' sings Professor Larkin, with cheerful relevance. And, indeed, when we stop to think of it, why not?

D. S. J.

SPECIAL ARTICLES.

TIME VARIATION OF THE INITIAL NUCLEATION OF WET DUST-FREE AIR.

IN the further development of the investigation¹ on the time variations of the efficient colloidal nucleation in filtered air, I find results of the same character as those already discussed; but the dependence of the nucleation on the fluctuations of the barometer shows itself even more obtrusively than before. The minima of atmospheric pressure coincide with maxima of the larger colloidal nucleation and therefore (by inference but not necessarily) with minima of ionization of the dust-free air, both in the daily and in the weekly periods of observations. Maximum pressure would correspond to maximum ionization as if the radiant energy originated in the compression of the atmosphere, or were dependent on the mass of the atmosphere bearing on a given place. This would, if finally substantiated, be an important result, but no more so than the correlative result that minimum pressure and maximum of the initial colloidal nucleation of dust-free air go together. The bearing of this on 'adsorption' of atmospheric ionization will be stated presently.

At the same time since the change of absolute temperature, t , due to sudden expansion equivalent to a drop δp at a barometric pressure p and vapor pressure π may be written

$$t_2/t_1 = (1 - \delta p / (p - \pi))^{(k - c)/c}$$

the correction for the changes of the barometer are in the same sense as the observed changes in nucleation. These corrections are found by varying the numerator of $\delta p / (p - \pi)$ and observing the effect on the angular diameter of the corona. While I see no room for error, it must nevertheless be acknowledged that the present method of small exhaustion (though possibly more sensitive) is not as straightforward as the method mentioned in my address where no variation could be detected, the terminal corona remaining unchanged.

At the present stage of investigation, therefore, the need of any cosmical radiation has ceased to be obvious and should be abandoned,

¹ SCIENCE, XXIII., p. 952, 1906.